Extreme Ultraviolet Lithography - Commissioning of an Offner 1:1 Imaging Camera	U13UB

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The Extreme Ultraviolet Lithography (EUVL) program is aimed at developing the basic technology required for the printing of semiconductors features of dimensions aprox. 100nm and below. The EUVL technique consists of diffraction limited imaging of 13nm light by means of Multilayer coated imaging optics.

This year saw the commissioning of the rebuilt 1X Offner Ring Field (EUVL) camera. This machine consists of a 3 mirror projection imaging camera with a Numerical Aperture (NA) of 0.0835. The mirrors are multilayer coated with 40 layer pairs of Mo/Si optimized to reflect at a wavelength of 13.4nm. This camera can image a patterned multilayer reflection mask onto a resist coated wafer. Masks and wafers are mounted on stages with the relevant 6 degrees of freedom. In many ways the machine represents the closest to what an EUVL stepper would look like if built with 1993-95 technology. By building such a machine one is forced to confront many of the problems that present day technology must surmount before this lithographic technology can become viable. The estimated timeframe for EUVL technology to come on line as a viable commercial tool is at around 2005.

The imaging performance of this machine was characterized. The nominal resolution of the camera by the Raleigh criteria (lambda/2NA) was 80nm. The camera was found to be capable of imaging 75nm lines and spaces, however the contrast was found to be poor. The fact that 75nm lines and spaces were printed at all indicates that the mirrors had good figure - this was confirmed by visible light interferometry which measured the mirror figure shape and was found to have an error of about 0.8nm rms over the used part of the optics. This is viewed as a quite good figure for this wavelength range, but a real stepper would require a factor of 4 improvement to maintain consistent imagery across the imaging field. The low image contrast that was observed is consistent with significant amounts of small angle scattering from the mirror surfaces. This is considered a problem with the mirror surface in the mid-spatial frequency range (ca. 1mm - 1micron). This spatial frequency region is still under investigation - its effect on imaging is at present poorly understood in a quantitative manner.

The commissioning of this machine highlighted the lack of understanding of how to specify mirrors. This is a common problem for x-ray mirrors. It is becoming apparent to the general optics community that optics require to be specified over the complete spatial bandwidth for them to perform their required function. Work to develop the understanding of what the full spatial bandwidth specification should be for future EUVL mirrors is underway.